

CLAIMS

1. Method of making microparticles having a metal-containing core encapsulated in a graphitic shell
5 containing hetero atoms, including the steps of
(i) forming, in a liquid medium, colloidal particles containing a first metal in the form of a metal-oxo species, the first metal being selected from Fe, Co, Ni and Pd, the particles being colloiddally stabilized by a
10 surfactant and containing in addition to the first metal source material of carbon and the hetero atoms, and
(ii) separating said particles from the liquid medium and pyrolyzing them in inert gas to yield the microparticles having said core and said graphitic shell containing said
15 hetero atoms encapsulating the core.
2. Method according to claim 1 wherein said metal containing core contains at least one phase selected from metal, alloy, metal carbide and metal oxide and, optionally, is ferromagnetic.
- 20 3. Method according to claim 1 or 2 wherein in step (i) at least one second metal is incorporated in said colloidal particles and is present in the core of the microparticles obtained.
4. Method according to claim 3 wherein said second
25 metal is a radionuclide.
5. Method according to any one of the preceding claims wherein step (i) is performed by forming a solution of a compound of said first metal in said liquid medium which is a polar solvent and heating said solution in the
30 presence of said surfactant and an oxidizing agent to convert said compound to said metal-oxo species and form said colloidal particles.

6. Method according to claim 5 wherein said oxidizing agent is selected from oxygen and a compound of a second metal which becomes incorporated in the colloidal particles.

5 7. Method according to any one of claims 1 to 4 wherein step (i) is performed by forming an emulsion having dispersed phase droplets stabilized by said surfactant and containing a dissolved compound of said first metal and oxidizing said compound of said first metal to
10 produce said metal-oxo species and form said colloidal particles.

8. Method according to claim 7 wherein said dispersed phase droplets include a dissolved oxidizing agent which is a compound of a second metal which becomes
15 incorporated in said colloidal particles.

9. Method according to any one of the preceding claims wherein said hetero atoms are selected from N, B, P, S and O.

10. Method according to claim 9 wherein said hetero
20 atoms are N.

11. Method according to any one of the preceding claims wherein said metal-oxo species is a metal complex including ligands selected from cyanide, isocyanide, cyanate and isocyanate, thereby acting as a source of
25 carbon and nitrogen as said hetero atom.

12. Microparticles having a core containing a radionuclide encapsulated by a graphitic shell.

13. Microparticles according to claim 12 wherein said core contains, in addition to said radionuclide, at least
30 one of Fe, Co, Ni and Pd.

14. Microparticles according to claim 12 or 13 wherein said graphitic shell contains chemically bound hetero atoms such that graphitic layers of the shell are curved.

15. Microparticles according to claim 14 wherein the
5 hetero atoms are N.

16. Method of making solid microparticles having a metal-containing core surrounded by a silica coating, including the steps of

10 (i) forming, in a liquid medium, colloidal particles containing a metal-containing species and colloidally stabilized by a surfactant, and
(ii) forming a silica coating around said colloidal particles by hydrolyzing a silicon compound in the region of the interface between the colloidal particle and the
15 liquid medium.

17. Method according to claim 16 wherein the colloidal particles contain a plurality of said metal-containing species of different metals.

18. Method according to claim 16 or 17 wherein the or
20 each said metal-containing species is selected from metal, alloy, metal oxide, metal hydroxide and metal carbide.

19. Method according to any one of claims 16 to 18 wherein said metal-containing species is ferromagnetic
25 and/or contains a radionuclide.

20. Method according to any one of claims 16 to 19 wherein in step (i) said colloidal particles are made by forming an emulsion having dispersed phase droplets stabilized by said surfactant containing a dissolved
30 compound of the metal and causing said metal-containing species to precipitate thereby forming said colloidal particles.

21. Method according to claim 20 wherein the precipitation of the metal-containing species is caused by addition of alkali.

22. Method according to any one of claims 16 to 21
5 wherein the silicon compound which is hydrolyzed is an alkoxy silane compound.

23. Microparticles each having a core comprising at least one metal-containing species which is ferromagnetic and/or contains a radionuclide and a coating of silica
10 gel encapsulating the core.

24. Microparticles according to claim 23 wherein said metal-containing species is selected from metal, alloy, metal oxide, metal hydroxide and metal carbide.

25. Microparticles according to claim 23 or 24 wherein
15 said silica gel has at its surface functional groups for the attachment of other species.

26. Microparticles according to any one of claims 23 to 25 wherein said silica gel is porous.

27. Microparticles according to any one of claims 23 to
20 26 wherein said cores have an average diameter in the range 1 to 100 nm, preferably 1 to 50 nm.

28. Microparticles according to any one of claims 23 to 27 wherein said coatings have an average thickness in the range 1 to 50 nm, preferably 2 to 10 nm.